

## Claims

- [c1] What is claimed is:
1. An extrusion-free wet cleaning process for post-etch Cu-dual damascene structures, the process comprising:  
providing a wafer comprising a silicon substrate and at least one post-etch Cu-dual damascene structure, the post-etch Cu-dual damascene structure having a via structure exposing a portion of a Cu wiring line electrically connected with an  $N^+$  diffusion region of the silicon substrate and a trench structure formed on the via structure;  
applying a diluted  $H_2O_2$  solution to the wafer to slightly oxidize the surface of the exposed Cu wiring line;  
washing away cupric oxide generated in the oxidation step by means of a cupric oxide cleaning solution containing diluted  $HF$ ,  $NH_4F$  or  $NH_2OH$ ; and  
preventing Cu reduction reactions on the  $N^+$  diffusion region connected Cu wiring line.
  2. The process of claim 1 wherein the Cu wiring line electrically connected with an  $N^+$  diffusion region of the silicon substrate serves as a cathode in the cupric oxide cleaning solution.
  3. The process of claim 1 wherein the method of preventing Cu reduction reactions on the Cu wiring line comprises purging inert gas onto the wafer during the application to the wafer of the diluted  $H_2O_2$  solution.
  4. The process of claim 1 wherein the method of preventing Cu reduction reactions on the Cu wiring line comprises adding a Cu corrosion inhibitor to the diluted  $H_2O_2$  solution.
  5. The process of claim 4 wherein the Cu corrosion inhibitor comprises benzotriazole (BTA).
  6. The process of claim 1 wherein the method of preventing Cu reduction reactions on the Cu wiring line comprises reducing the  $H_2O_2$  concentration of the diluted  $H_2O_2$  solution to below 100:1 (v/v).

- [c7] 7.The process of claim 1 wherein the method of preventing Cu reduction reactions on the Cu wiring line comprises lowering the temperature of the diluted  $H_2O_2$  solution to below 15 ° C during the application to the wafer of the diluted  $H_2O_2$  solution.
- [c8] 8.The process of claim 1 wherein the method of preventing Cu reduction reactions on the Cu wiring line comprises increasing the pH of the acidic cupric oxide cleaning solution to above 7.
- [c9] 9.A wet cleaning process comprising:  
an oxidation step;  
an oxide etch step for washing away cupric oxide generated in the oxidation step by means of a cupric oxide cleaning solution; and  
reducing Cu deposition on a cathode-like copper wiring line of a Cu-dual damascene structure.
- [c10] 10.The process of claim 9 wherein the oxidation step is used to slightly oxidize a surface of a Cu wiring line in a dual damascene structure by utilizing a diluted  $H_2O_2$  solution.
- [c11] 11.The process of claim 9 wherein the cupric oxide cleaning solution comprises diluted HF,  $NH_4F$ ,  $NH_2OH$ , or diluted HF/HCl.
- [c12] 12.The process of claim 9 wherein the oxide generated in the oxidation step comprises  $CuO_x$  and  $Cu(OH)_2$ .
- [c13] 13.The process of claim 9 wherein the cathode-like copper wiring line is electrically connected with an  $N^+$  diffusion region of a silicon substrate.
- [c14] 14.The process of claim 9 wherein the process of reducing Cu deposition on a cathode-like copper wiring line comprises purging an inert gas during the oxidation process.
- [c15] 15.The process of claim 9 wherein the process of reducing Cu deposition on a cathode-like copper wiring line comprises adding a Cu corrosion inhibitor to the diluted  $H_2O_2$  solution.

- [c16] 16.The process of claim 15 wherein the Cu corrosion inhibitor comprises benzotriazole (BTA).
- [c17] 17.The process of claim 9 wherein the process of reducing Cu deposition on a cathode-like copper wiring line comprises reducing the  $H_2O_2$  concentration of the diluted  $H_2O_2$  solution to below 100:1 (v/v).
- [c18] 18.The process of claim 9 wherein the process of reducing Cu deposition on a cathode-like copper wiring line comprises lowering the temperature of the diluted  $H_2O_2$  solution during the oxidation step to below 15 ° C.
- [c19] 19.The process of claim 9 wherein the process of reducing Cu deposition on a cathode-like copper wiring line comprises increasing the pH of the cupric oxide cleaning solution to above 7.

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